Integration of Coal Gasification and Reburning

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GE EER is developing an innovative method for controlling NO_x emissions from coal-fired boilers while improving byproduct characteristics. The method is called Fuel-Flexible Reburning (FFR). In FFR, solid fuel is partially gasified before injection into reburning zone. FFR increases the efficiency of NO_x reduction in reburning and may decrease carbon-in-ash. The work includes a combination of analytical and experimental studies to identify optimum process configurations and develop a design methodology for full-scale applications.

Tests were performed in a 1.0×10^6 Btu/hr Boiler Simulator Facility (BSF). Natural gas was used as the primary fuel and coal and biomass were used as reburning fuels. The reburning fuel was partially gasified in a gasifier. Heat required for solid fuel gasification was supplied by the combustion of natural gas in air. Char and gas-phase products of the gasification were injected into the BSF reburning zone. Nitrogen or air was used as a transport media for the reburning fuel. A temperature profile in the gasification zone was measured using several thermocouples located along the zone. A port located near the exit of the gasifier allowed gas and solid samples to be taken and analyzed. Heat input of the reburning fuel, defined as percent of the total BSF heat input, varied from 10% to 25%.

Tests demonstrated that partial fuel gasification prior to injection into the reburning zone resulted in an increase in NO_x reduction. Several coals with different volatiles content, sewage sludge and almond shells were tested. Data suggested that incremental increase in the efficiency of NO_x reduction due to the gasification was more significant for less reactive coals with low volatiles content. Coals with low volatiles content are usually less reactive in basic reburning. Coal gasification improves their reactivity by producing gas-phase combustible species prior to the injection into reburning zone. Coals with high volatile content are easily gasified in the reburning zone and thus benefit less from gasification prior to injection.

Experimental results suggested that the efficiency of NO_x reduction with gasified coal was higher when air was used as a transport media. Up to 14% increase in the efficiency of NO_x reduction in comparison with that of basic reburning was achieved with air transport. The extent of coal gasification was more significant in the presence of air since temperatures in the gasification zone were higher. Residence time in the gasification zone also affected the efficiency of NO_x reduction in FFR. Coal gasification in the temperature range of 1400 – 1600 ^oF resulted in the production of hydrocarbons, CO, H_2, and char. Tests demonstrated that NO_x reduction was maximum at a gasifier residence time of about 1 s.

Gasification products of sewage sludge and almond shells provided 60% and 66% NO_x reduction, respectively. Optimum amount of the reburning fuel heat input depended on the fuel-N content of biomass: it decreased with increasing fuel-N content.

Future work will continue pilot-scale tests and develop tools required to move the technology to a demonstration stage. More pilot-scale tests will be conducted to characterize and optimize FFR. An engineering and economic analysis of FFR will be conducted to confirm economic benefits of the FFR technology as compared to conventional reburning and other commercial NO_x control technologies, and to develop a full-scale FFR design methodology.